On the Change in the adopted Unit of Time. By Major-General J. F. Tennant, R.E., F.R.S.

Mr. Stone's papers on the cause of the large error in our modern Tables, and the criticisms I have seen on them, have led me to consider the subject; and I put my idea on paper because it may simplify the question to some. The result is the same as Mr. Stone's, and the reasoning, though independently thought out, is in much the same line as part of his second paper in the *Monthly Notices.*

For many years past the use of the Sun for the purpose of regulating clocks in an Observatory has ceased. Practically all observations are made in Sidereal Time, and the Mean Time where required has been deduced from it; and even where series of observations have been used in the investigation for Tables the Times have been reinvestigated, the clock-errors having been determined by the observations of stars. Therefore the Mean Times used have essentially depended on the length of the mean solar day in seconds of sidereal time. The Julian year taken at 365·25 mean solar days therefore depends on this time. The relation between the solar and sidereal days has been practically till recently that determined by Bessel, and it is from observations dated in what we may call Besselian Mean Time that the investigations of physical astronomy have deduced the data of modern Tables.

One of the discoveries from these investigations has been that the mean motion of the Sun and the length of the mean solar day in sidereal seconds dependent on it were not sufficiently accurate. The result of introducing the new Tables has been that, while the sidereal day and second are unchanged, the unit of Observatory Mean Time has become the Leverrian solar day* and year instead of the Besselian, and there has also been a small jump. Now, the data of, say, Leverrier's Tables having been determined from observations dated in Besselian Time should be consistent with fresh observations so dated. When compared with those dated by the Observatory clocks they do not agree, there is an apparent error of the Tables, which is really due to the fact that we are comparing a theoretical state of things at a Besselian date with the actual state at a Leverrian date nominally the same.

The Epoch of Leverrier's Elements is Jan. 1·0 1800 in Besselian Time, which is not the same physical instant as Jan. 1·0 1800 of Leverrian Time or that of the present *Nautical Almanac*, and the Elements require correction for the difference.

* The Mean Year or Mean Interval between two passages of the Sun through the first point of *Aries* is determined by observation as 366 Sidereal days $+n$ seconds, and this necessarily equals 365 Mean Solar days $+n$ Solar seconds. If n be wrongly determined, the change will not be in the length of the Sidereal day and second, but in that of the Solar day and second.

The mean motions, again, are for Besselian mean days and Julian years, and to make them correct for the dates of our present *Nautical Almanac* they require to be multiplied by

$$\frac{\text{Sidereal Seconds in Leverrian Mean Day}}{\text{Sidereal Seconds in Besselian Mean Day}}.$$

Hansen's or other Tables of the Moon will require a corresponding set of corrections to adapt them to our Observatory Times.

It is, however, unnecessary to correct the Tables. All we need do is to recollect that the data in our present *Nautical Almanac* are the direct result of the Tables, and that they must be corrected for the difference between the Mean Time used in making the Tables and the Leverrian Mean Time of the Observatories. Thus, if the difference between the Mean Time which Hansen's Tables are referred to and Leverrian Time is n^s on any day, the latter being the smaller we must compare the Moon's Right Ascension at Transit with that which according to the almanac she would have had n^s after the Transit.

When the data of the Tables have been entirely determined from observations reduced as I have described, then the Tables require only this correction of date. But there have been used some isolated old observations such as eclipses of the Sun in the Lunar Tables and Transits of *Venus* and *Mercury* whose times can only be determined by solar observations, or are given by observers in Apparent Time without means of referring to stars. In these cases the Mean Times are Leverrian, or *True* Mean Times, within the limits of observation, and we should expect a discordance with the calculations made from the provisional data. By using them to correct the data of the Tables on the hypothesis that these times were Besselian, error has been introduced. A marked case is that of the Secular Acceleration of the Moon's Mean Motion which has been determined practically from very old eclipses compared with the Tables whose mean motion came from modern observations.

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Remarks on Mr. Stone's Explanation of the Large and Increasing Errors of Hansen's Lunar Tables by means of a supposed Change in the Unit of Mean Solar Time. By Prof. J. C. Adams, M.A., F.R.S.

In some recent communications to the Royal Astronomical Society Mr. Stone contends that the mean solar day in use before 1864—when Le Verrier's Solar Tables were substituted for Bessel's in calculating the sidereal time at mean noon given in the *Nautical Almanac*—differs from the mean solar day adopted since that time.